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THE GROWTH OF GRADUATE EDUCATION IN THE POST-SPUTNIK ERA

ED 077473

by

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INTRODUCTION

Graduate education in the United States has grown at an astounding rate since the launching of Sputnik I in October of 1957. Graduate enrollments doubled in the seven-year period between 1957 and 1964, and it appears likely that they will come close to doubling again in the seven-year period between 1964 and 1971.

For the most part the graduate enrollment expansion has been absorbed by the approximately 650 institutions that were already offering graduate programs in 1957, but close to 200 additional institutions have begun offering graduate programs for the first time. To the dismay of many educators, the number of doctorate-granting institutions has been increasing at a rate of 15-20 per year in the last few years, and a recent survey by Mayhew [20] indicates that over a hundred new doctorate-granting institutions may be added between now and 1980.

Doctorate production has tripled during the last ten years. There were more Ph.D.'s produced in American universities during this decade than in the entire previous history of the United States, and the postwar baby boom hasn't reached the Ph.D. stage yet. Although the annual rate of increase in doctorate production in the 1970's will slow somewhat from the average rate of 12% per year in the 1960's, the number of living Ph.D.-recipients from American universities will surely double between 1970 and 1980, and an increase of 160% in the stock of Ph.D.'s is not beyond the realm of possibility.

In the past, about half of the new Ph.D.'s have gone into college teaching, and most Ph.D. programs are geared to producing research-oriented academicians, often overspecialized to the point of absurdity. However,

with total enrollment in all colleges and universities expected to increase by only 50-60% during the next ten years [15], the demand for new Ph.D.'s to fill college teaching positions could be met even if future Ph.D. production did not rise above the 1970 level. The demand for highly trained personnel in other occupations might absorb a sizable portion of the future increases in doctorate production, but there may already be a crisis of oversupply in some fields. This problem poses serious questions at all levels -- federal, state, institutional, departmental, and individual -- not only about the numerical aspects of graduate education associated with costs, enrollments, and degrees, but about the nature of graduate education itself.

This study attempts to provide a more detailed analysis of the factors affecting the growth of graduate education than has been attempted in the past, with the hope that a better knowledge of the flow of graduate students through the universities will provide a firmer basis for giving partial answers to some of the grave questions facing graduate education today. In particular, a more detailed analysis is needed to provide better projections of future graduate enrollments and degree production. As an indication of how poor the past projections of doctorate production have been, one can compare the several sets of projections from various sources collected by Cartter [9] in 1965 with the actual degree production during the past five years. According to these projections, which were prepared by the U. S. Office of Education, the National Science Foundation, the National Academy of Sciences, and Cartter himself, doctorate production would rise about 30-40% between 1964 and 1969. The actual percentage increase for the five-year period was 81%. This lack of reliability may only confirm the unpredictability of future doctorate production, but more likely it indicates that a more thorough analysis is needed.

The annual projections of enrollments and degree production by the National Center for Educational Statistics of the U. S. Office of Education are widely quoted, despite their lack of reliability in the past. In my opinion, the methodology behind these projections, which typically consists of extrapolating lines fitted to ratios of enrollments (or degree production) to sizes of certain age groups over a ten-year time period, should be revised for the following reasons: (1) the wartime effects upon enrollments and degree production are ignored; (2) no adjustments are made when the ratios being fitted are rising in a non-linear fashion over the time interval under consideration; (3) the reclassification of degrees or enrollments in certain categories is not considered in the fitting process. The first criticism above also applies to other past analyses of the statistics of graduate education. As will be seen below, the wartime effects due to the draft and the G. I. Bills have significantly affected graduate enrollments in the post-Sputnik era, and they will continue to do so in the near future.

THE DATA ON GRADUATE ENROLLMENTS

One reason a more detailed analysis of graduate enrollments has not been made in the past has been the lack of suitable historical data. For the past few years the data on graduate enrollments provided by the National Center for Educational Statistics (NCES) have been such a jumble that one encounters enough difficulty determining reasonable estimates of the past enrollments without worrying about the future.[1] However, recently released data from NCES in conjunction with data from the relatively consistent series of NCES publications Students Enrolled for Advanced Degrees now provide more detailed and reliable information on graduate enrollments than has been available up to this time.

The data on graduate enrollments that will be considered in this study are given in Table 1. The graduate resident enrollments given in the table exclude the extension students but include the graduate-level students who are not working toward advanced degrees. Both the graduate resident enrollments and the enrollments for advanced degrees exclude the first-professional students, who numbered about 150,000 in the fall of 1969. (The total post-baccalaureate enrollment in 1969, including the extension and first-professional students, was about 1.1 million.) First-year students are those students who have completed less than one full year of required study for an advanced degree; terminal year students are those who are expected to complete all doctoral requirements by the end of the academic year.

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[1] Users of the recently released NCES publication Projections of Educational Statistics to 1978-79 should take into account the fact that the estimates of graduate resident enrollment given there for the years 1964 to 1968 are based upon data from the 1963 residence and migration survey. These estimates will be changed significantly in the next edition of the Projections. For example, the estimated graduate resident enrollment for 1966 of 624,000 will be increased to 682,000.

Table 1

Graduate Resident Enrollment and Enrollment for Advanced Degrees in the United States, Fall Term, 1955-1969
(All data are in thousands)

Year	Graduate resident enrollment			Enrollment for advanced degrees											
				All levels			First-year			Intermediate			Terminal year		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
1955	171	69	240	157	58	215	88	41	130	62	14	76	8.7	0.9	9.6
1956	188	74	262	172	63	235	98	45	144	66	15	81	9.2	1.0	10.2
1957	194	76	270	178	65	243	102	47	149	68	15	83	9.5	1.0	10.5
1958	219	86	305	201	73	274	118	54	171	74	17	91	10.5	1.0	11.5
1959	241	95	336	221	81	302	131	60	192	80	18	98	11.2	1.2	12.4
1960	256	103	358	235	87	322	140	66	206	84	19	103	11.7	1.3	13.0
1961	277	111	388	253	94	347	152	71	223	90	21	111	12.0	1.3	13.3
1962	305	127	432	276	107	383	166	80	246	99	24	123	12.4	1.5	13.9
1963	334	144	477	303	121	424	186	92	277	104	27	130	14.2	1.8	16.0
1964	374	166	540	338	139	477	210	107	317	112	30	142	15.4	2.2	17.6
1965	416	191	607	375	159	534	235	123	358	123	34	157	16.9	2.5	19.4
1966	451	214	665	405	177	582	253	136	388	131	38	169	20.9	3.4	24.3
1967	496	247	743	443	204	648	269	157	426	150	43	193	24.3	4.2	28.5
1968	524	284	808	468	234	702	278	178	456	161	50	211	28.9	5.4	34.3
1969	550	320	870	491	263	755	295	198	492	167	59	226	30.0	6.4	36.4

The precision and completeness of the estimated enrollments indicated in Table 1 grossly misrepresent the state of the available data. The entries in the table result from piecing together the available data on enrollment for advanced degrees by level, which were not reported separately by sex before 1966, with the data on graduate resident enrollment by sex, which were gathered biennially up to 1963 and in 1968. There was no survey of enrollment for advanced degrees before 1959, so that all the data in the table for the years 1955-1958 on enrollment for advanced degrees are estimated, but the growth rate indicated for total enrollment by sex is consistent with the growth rate in graduate resident enrollment. The sources of the data and methods used in estimating missing values are given in the appendix.

As an indication of how rapidly total graduate enrollment has risen relative to the numbers of college graduates, Figure 1 gives a plot of the ratio of graduate resident enrollment for each year to the total number of bachelor's degrees during the preceding three years. Expressed symbolically, the ratios plotted in Figure 1 are $G(t) / [b(t) + b(t-1) + b(t-2)]$ where $G(t)$ denotes the graduate resident enrollment during the fall term of year t and $b(t)$ denotes the number of bachelor's degrees awarded during the academic year ending in year t. The dotted lines in Figure 1 represent projected values of the ratios according to three series of projections to be discussed in a later section.

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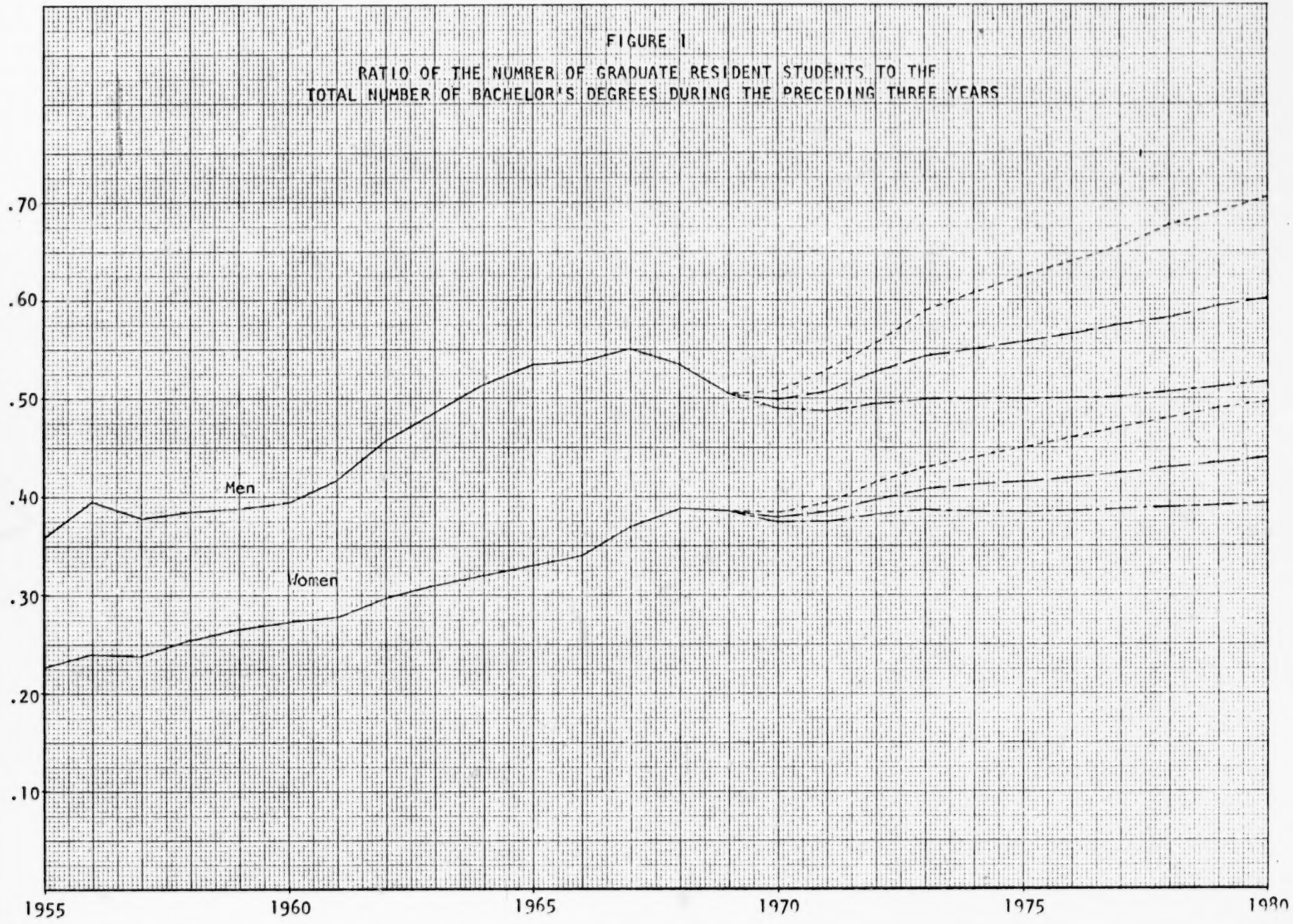
FIGURE 1

RATIO OF THE NUMBER OF GRADUATE RESIDENT STUDENTS TO THE TOTAL NUMBER OF BACHELOR'S DEGREES DURING THE PRECEDING THREE YEARS



SOME FACTORS AFFECTING GRADUATE ENROLLMENTS

Any serious attempt to analyze the growth of graduate education since 1957 must necessarily treat a number of factors that affect the graduate enrollment pattern. Foremost among these are: the draft, the G. I. Bills, federal support for graduate students, other economic factors, foreign student enrollments, and the demand for highly trained manpower.

There has been considerable speculation during the past three years about the impact of recent changes in Selective Service regulations upon graduate enrollments. In February 1968, the National Security Council, headed by President Johnson, eliminated draft deferments for all graduate students not already in their second year of study except for those in medicine and dentistry. Under the policies in effect at that time, which specified that the older members of the draft pool would be inducted first, the projected consequences of this decision were alarming:

> It is entirely likely that 288,000 young men will be drafted in the 12 months starting in July (1968) and that virtually all of them will hold one or more college degrees...There will be a 70 per cent drop in the number of college men entering graduate school next fall and a 40 per cent drop in overall enrollment.... (United Press International, Oakland Tribune, April 5, 1968)

Perhaps such projections served to forestall a full immediate implementation of the Security Council directive. Also, draft calls during the second half of 1968 numbered less than half those called during the first six months. At any rate, the projections proved to be overly pessimistic. According to an NCES survey [27], enrollment for master's and doctor's degrees was up 8.3% in 1968 over 1967 (5.5% for men and 14.4% for women). This does not mean that the draft law change had a negligible effect upon the 1968 graduate enrollment pattern. For example, although

first-year enrollment in 1968 was up 3.2% and 13.7% for men and women respectively, full-time first-year enrollment for men was down 2.5%, whereas it was up 24.1% for women.

Since the dire predictions for graduate enrollments did not materialize in 1968, perhaps because of the reduced draft calls in the latter half of that year, it then seemed reasonable to expect that the brunt of the impact of the draft would be upon the 1969 graduate enrollment. Yet, enrollment for master's and doctor's degrees was up 5.1% for men and 12.5% for women in the fall of 1969 over 1968; first-year enrollments were up 6.0% and 10.7% for men and women respectively, and full-time first-year enrollments were up 6.8% and 10.7%. (See [28].) However, as Figure 1 suggests and as the analysis later in this paper will show, this superficial look at enrollment increases is very misleading. It conceals a very sharp reduction during the last few years in the proportion of men who have entered graduate school after receiving their bachelor's degrees.

This discontinuity in the graduate enrollment pattern due to the draft should have ended in 1969 since the numbers of draft calls have been reduced significantly in 1970 and 1971. Whereas there were close to 300,000 draft calls in both 1968 and 1969, the total number of draft calls was down to 163,500 in 1970 [40], and Secretary of Defense Melvin Laird recently predicted an even lower total for 1971. Also, the burden of the draft has been shifted to the 19-year-old age group beginning in 1971, although those college graduates who have received student deferments in the past will still be affected.

Beginning in 1970, one can expect the losses in graduate enrollments due to the draft to be more than offset by the numbers of veterans returning to the campuses under the new G. I. Bill (Chapter 34, Title 38, U. S. Code), which applies to Vietnam era veterans and all other post-Korean veterans

who have served in the Armed Forces since January 31, 1955. According to the Veterans Administration [11], the number of veterans attending colleges and universities in November 1969 was 432,296; by November 1970 the number had increased by 36% to 590,053, of whom 88,213 were graduate students. These veterans comprise over 10% of the total male postbaccalaureate enrollment in 1970.

In all likelihood, this proportion will grow for the next two or three years. For one thing, many of those veterans who return to school at the undergraduate level will continue on to graduate school, but also many of those graduate students who have been drafted during the last two years will return to the campuses to continue their work at the graduate level after their two years in the service.

Except for the rapidly increasing expenditures on veterans during the last few years, the federal government has cut the growth rate of its support for graduate students sharply. According to a recent Office of Education report by Joseph Froomkin [13], it is estimated that total federal aid for predoctoral students, including payments to research assistants but excluding medical students' aid programs, will have increased from $409 million in fiscal 1967 to $572 million in 1970. However, much of the increase in federal aid during this period was in the form of direct and insured loans by the Office of Education and payments to veterans under the G. I. Bill; when these latter amounts are subtracted out of the total, the net amount of other stipends to graduate students was $300 million in 1967 and is expected to be about $338 million in 1970. During this same three-year period, the amount of loans, both direct and insured, administered by the Office of Education will have more than doubled -- from $63 million in 1967 to $133 million in 1970. Thus, the current

Administration has changed the federal government's past policy of giving federal support to graduate students through fellowships and traineeships to that of providing guaranteed loans.

Additional numbers of graduate students, postgraduate students, and professors are supported by federal grants for research and development. The National Science Foundation reports in [32] that the increase in total federal obligations to universities and colleges between 1967 and 1969 was only 4%.

In order to get a better idea of what effect the decreased rate of growth of federal support for graduate education will have upon future enrollment patterns, one needs to examine the extent to which graduate enrollment today is dependent upon federal support. In 1960 there were fewer than 10,000 fellows and trainees supported by the federal government. By 1968, this figure had climbed to an estimated 64,000 fellows and trainees, excluding research assistants and veterans attending colleges under the G. I. Bill [13]. During the same period, graduate resident enrollment increased about 125%, but it's hard to attribute much of this growth to federal support, because the 64,000 federally supported students in 1968 still comprised only about 6% of the total postbaccalaureate enrollment of 1,037,000 students.

An Office of Education survey taken in the spring of 1965 showed that about 43% of the graduate students surveyed (first-professional students were excluded) held stipends of some kind -- scholarships, fellowships, teaching assistantships, or research assistantships. Most of these stipends were awarded by the institutions themselves, commonly in the form of teaching and research assistantships. Table 2 summarizes the students' primary sources of support.

Table 2

Primary sources of funds used to finance graduate study, by enrollment status and sex: Spring 1965

Source	Men		Women	
	Full-time	Part-time	Full-time	Part-time
	Percent			
Fellowship	19	1	22	1
Scholarship	2	1	3	1
Research assistantship	10	2	6	1
Teaching assistantship	12	3	9	3
Faculty appointment	2	5	2	3
Own employment	18	77	15	67
Spouse's employment	17	5	18	17
Gifts or loans from relatives	7	1	10	2
Withdrawals from savings	6	2	7	2
NDEA loan	1	0	1	0
Commercial loan	1	0	1	0
University loan	1	0	1	0
Other sources	3	1	4	2

SOURCE: National Center for Educational Statistics, The Academic and Financial Status of Graduate Students, Spring 1965, U.S. Government Printing Office, Washington, 1967.

The table shows that graduate students do not depend upon stipends as their primary means of support as heavily as is commonly assumed in some academic circles. Most of the part-time students list their own or their spouse's employment as their principal source of income, and even among the full-time students less than half depend upon stipends as their principal means of support. Moreover, when one considers that research and teaching assistantships are not "gifts" in any sense of the word since students are merely being paid for essential services that they perform, often at a very low rate of pay, then it becomes clear that most graduate students depend primarily upon their own resources for their support.

Although one can attribute only a small part of the phenomenal growth in graduate enrollments in the post-Sputnik era to increased financial support for graduate students during this period, the availability of grants has permitted more students to attend on a full-time basis, thus increasing the proportion of students who complete advanced degree programs and cutting the time required to earn these degrees. Nevertheless, a slowdown in the rate of increase of graduate student support should not, in itself, have much of an effect upon total graduate enrollment and Ph.D. production. Most of the Ph.D. students who receive federal scholarships and traineeships probably rank among the top students within their departments; those who would lose their federal stipends would still be able to compete favorably for research assistantships, teaching assistantships, and other means of employment while pursuing their degrees. Also, one can expect graduate students to depend in the future more upon loans and upon gifts from their families.

If there is a further cutback in federal support for graduate students, one might anticipate a drop in the proportion of students who are able to attend on a full-time basis, except among the veterans attending under the G. I. Bill. The proportion of full-time students among the students enrolled for master's and doctor's degrees, which had remained stable at about 40% from 1960 to 1963, increased sharply between 1964 and 1966 as the U. S. became increasingly involved in the Vietnam war. It reached 46% in 1966 and has remained essentially constant since that time. Among the men, 49% were enrolled full-time in 1969, as compared with only 38% of the women. Most of the enrollment for first-professional degrees is on a full-time basis; in 1969, the proportion of full-time students was about 90% for both sexes.

The classification of graduate students by their status as full-time or part-time students may not be too meaningful. For example, many of the so-called full-time students actually hold teaching and research assistantships which require the students to spend a certain proportion of their time, often half or more, performing duties that are not ordinarily applicable to meeting their degree requirements. As an indication of how many full-time students are really part-time employees of their universities, the National Science Foundation reported in [31] that over 45% of the full-time science graduate students in 1969 held research or teaching assistantships.

Most of the federal support for graduate students in the past decade has gone to graduate students in the sciences and engineering as a result of the Sputnik-inspired drive for U. S. preeminence in these fields. These fields are now taking the brunt of the federal cutbacks. According to the recent NSF publication [31], federal funds provided major support for

about 37% of the full-time science graduate students enrolled in 1969. Fellowships and traineeships provided the major source of support for 30% of the full-time science students, with about two-thirds of these awards dependent on federal funds. Thus, the science graduate students depend far more heavily upon federal support than the other graduate students, and the recent changes in federal policy can be expected to have a more pronounced effect in these fields.

Whereas total federal support for graduate students by government agencies, excluding loans and veterans' benefits, is estimated to rise from $300 million in fiscal 1967 to $338 million in 1970, the combined total support by NSF, the Department of Defense, the Atomic Energy Commission, NASA, and the Public Health Service may actually show a slight decrease -- from $176 million in 1967 to an estimated $175 million in 1970 -- according to estimates cited by Froomkin [13].

One source of evidence of the effects of the draft and the reduction in the growth rate of federal support for graduate students, especially in the sciences, is in the enrollment pattern of first-year graduate students by field of study. (See Table 3.) Since first-year graduate enrollment includes returning students who have completed less than one year of graduate work as well as the new students, the percentages in the table do not quite represent each field's "take" of the new entrants into graduate school, but they provide a good indication of how the enrollment pattern is shifting among the fields.

For the most part, the proportions have been quite stable during the nine-year period covered by the table. It might have been conjectured that the proportion of students entering the social sciences, business and commerce, and education would rise during the period of mobilization

Table 3

Trends in First-year Enrollment for Advanced Degrees by Field of Study, 1960-1969

Field	Percent of Total First-year Enrollment									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Agriculture	0.9	0.8	0.8	0.7	0.8	0.8	0.7	0.6	0.6	0.6
Architecture	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Biological Sciences	3.6	3.5	3.4	3.6	3.7	3.8	3.8	3.5	3.2	3.3
Business & Commerce	9.0	8.8	8.7	9.1	10.3	10.7	10.9	10.8	10.9	11.3
City Planning	---	---	---	---	---	---	0.2	0.2	0.3	0.3
Comp. Sci. & Sys. Analysis	---	---	---	---	0.1	0.2	0.4	0.5	0.6	0.8
Education	36.0	37.2	37.4	36.1	33.4	33.6	33.9	35.5	37.1	36.6
Engineering	10.1	9.9	10.0	10.1	9.5	9.1	8.7	7.9	7.5	7.4
English & Journalism	4.2	4.4	4.5	4.8	4.8	4.9	4.9	4.8	4.5	4.5
Fine & Applied Arts	3.0	3.1	3.1	3.2	3.2	3.4	3.4	3.5	3.5	3.5
Foreign Languages & Lit.	1.7	1.8	1.9	2.1	2.2	2.3	2.5	2.4	2.3	2.2
Forestry	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.1
Geography	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Health Professions	1.8	1.6	1.5	1.5	1.4	1.5	1.5	1.3	1.6	1.5
Home Economics	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
Law	0.6	0.6	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.5
Library Science	0.6	0.6	0.6	0.6	2.0	1.9	2.1	1.9	1.9	1.8
Mathematical Subjects	3.8	3.6	3.7	3.7	3.7	3.6	3.4	3.1	2.9	2.8
Philosophy	0.5	0.5	0.5	0.6	0.6	0.5	0.6	0.5	0.5	0.4
Physical Sciences	6.2	5.6	5.5	5.4	5.1	4.7	4.5	4.0	3.7	3.4
Psychology	2.8	2.6	2.6	2.6	2.4	2.4	2.3	2.4	2.3	2.5
Religion	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.3	1.4	1.1
Social Sciences	11.3	11.2	10.9	11.3	11.9	11.9	11.4	11.2	10.5	10.9
Other	1.6	1.8	1.7	1.5	1.9	1.8	1.7	2.9	3.1	3.2

SOURCES: National Center for Educational Statistics, Students Enrolled for Advanced Degrees, Fall 1969, and earlier publications in this series.

for the Vietnam War, especially between 1964 and 1966, because these fields tend to have less stringent entrance requirements than those in the natural sciences and therefore might attract more students who might not enter graduate school otherwise except to evade the draft. However, the table provides almost no evidence to support this conjecture.

There have been rather sharp declines in the proportions of first-year students enrolled in engineering, mathematics, and the sciences in the last few years paralleling, but not necessarily resulting from, the reduced rate of growth in federal support for graduate students in these fields. It might be argued that these declines are attributable to effects of the draft since the male-dominated fields of engineering and the physical sciences show the largest declines between 1965 and 1968, and education, where over half of the graduate students are women, showed the largest gain. However, this argument may lack substance, as can be seen from Table 4, which shows that the same proportions computed separately for men and women for the years 1966-1969 show approximately the same pattern as those in Table 3.

It might also be argued that the shift in the enrollment pattern among fields merely reflects the anticipated market for advanced degrees in these fields. Yet this shift in the enrollment pattern took place before the current job squeeze for engineers, chemists, and physicists became apparent, whereas the demographic evidence pointing to a surplus of elementary and secondary school teachers has been well publicized. To say the least, the evidence is rather weak that the new graduate students were bypassing the hard sciences between 1964 and 1968 to major in education (and religion!) because of a better long-term employment outlook in these fields.

Table 4

Trends in First-year Enrollment for Advanced Degrees
by Sex and by Field of Study, 1966-1969

Field	Percent of Total First-year Enrollment							
	Men				Women			
	1966	1967	1968	1969	1966	1967	1968	1969
Agriculture	1.1	1.0	0.9	1.0	0.1	0.1	0.1	0.1
Architecture	0.3	0.3	0.3	0.3	0.0	0.0	0.1	0.1
Biological Sciences	4.4	4.0	3.7	3.8	2.8	2.6	2.5	2.6
Business & Commerce	16.3	16.4	17.1	17.9	1.0	1.2	1.2	1.5
City Planning	0.3	0.3	0.4	0.4	0.1	0.1	0.1	0.2
Comp. Sci. & Sys. Analysis	0.6	0.7	0.8	1.2	0.1	0.1	0.1	0.3
Education	23.7	25.1	26.2	25.2	52.8	53.2	54.1	53.6
Engineering	13.3	12.4	12.2	12.2	0.2	0.2	0.2	0.2
English & Journalism	3.4	3.5	3.0	3.0	7.5	7.2	6.8	6.7
Fine & Applied Arts	2.9	3.0	2.8	2.9	4.5	4.4	4.6	4.5
Foreign Languages & Lit.	1.7	1.6	1.5	1.4	4.0	3.8	3.6	3.5
Forestry	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Geography	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2
Health Professions	1.3	1.0	1.3	1.3	1.9	1.8	1.9	1.9
Home Economics	0.1	0.0	0.1	0.1	1.3	1.4	1.3	1.3
Law	0.8	0.8	0.8	0.7	0.0	0.1	0.0	0.0
Library Science	0.6	0.5	0.5	0.5	4.8	4.3	4.1	3.7
Mathematical Subjects	4.0	3.6	3.4	3.2	2.2	2.1	2.1	2.1
Philosophy	0.7	0.7	0.6	0.6	0.3	0.3	0.2	0.2
Physical Sciences	6.1	5.6	5.3	4.9	1.3	1.3	1.2	1.2
Psychology	2.4	2.4	2.4	2.6	2.1	2.3	2.2	2.3
Religion	1.5	1.7	1.9	1.4	0.6	0.7	0.6	0.5
Social Sciences	12.2	12.2	11.3	11.8	10.1	9.4	9.3	9.5
Other	1.6	2.6	2.8	2.9	2.0	3.4	3.5	3.7

SOURCES: National Center for Educational Statistics, Students Enrolled for Advanced Degrees, Fall 1969, and earlier publications in this series.

Although the recent decline in the proportion of first-year students enrolled in the physical sciences has paralleled the leveling off of federal support in those fields, this is apparently not the principal cause of the shifts. Instead, one must seek the main causes of the shift at the undergraduate level because, for the most part, the shifts among fields at the graduate level merely postdate by a year or two corresponding shifts at the undergraduate level. For example, between 1960 and 1968 the proportion of bachelor's and first-professional degrees awarded to engineering students dropped from 9.7% to 5.6%; in the physical sciences the proportion dropped from 4.1% to 2.9% during this period; for all natural sciences and related professions, the proportion dropped from 29.5% to 23.3% [25]. There has been a definite swing from the natural sciences to the social sciences and humanities at the undergraduate level during the 1960's, and with few exceptions the graduate enrollment pattern has swung the same way.

As an indication of possible future trends, the emerging field of computer science and systems analysis, which has a small proportion of women students, has grown at a phenomenal rate during the past few years despite the effects of the draft. Total 1969 enrollment for advanced degrees in this field was up 59% over the 1968 enrollment. Other rapidly growing fields and their percentage increases were: architecture (37%), city planning (28%), business and commerce (16%), home economics (16%), geography (14%), and fine and applied arts (11%).

The cutback in the level of federal support for the sciences will also have a marked effect on the availability of support for foreign students. The Institute of International Education [19] reports that there were about 135,000 foreign students in the U. S. in 1969, of whom 59,000 were graduate students. Although the foreign students comprised

only about 5% of the total postbaccalaureate enrollment in 1969, they constitute a much higher proportion of the graduate enrollment in the sciences. Also, the proportion of full-time enrollment among foreign students is higher than among American students. A recent NSF report [31] estimated that, among the full-time graduate students in the sciences in 1969, 20% were foreign students. They held about 30% of the research assistantships, a fifth of the teaching assistantships, and an eighth of the traineeships and fellowships.

The economic slowdown during the last two years may also have affected the graduate enrollment rates, but here the evidence is not at all clear whether the effect has been to push enrollment rates up or down. The author's analysis of undergraduate enrollments since World War II (see [15]) indicated that the undergraduate enrollment rates were apparently insensitive to the economic recessions of 1948-49, 1953-54, 1957-58, and 1960-61; the evidence suggests that the enrollment rates were even inflated during the Great Depression of the 1930's. My personal impression from experience with students at the University of California is that, whereas a few students may have had to drop out of graduate school because of economic problems during this period, and some college graduates may have decided not to go to graduate school for economic reasons, this is being offset by the numbers of new graduates who are entering graduate school because they have been unable to find suitable jobs during this period and they hope to upgrade their potential for later employment.

To confound the issue further, graduate students in many fields have suddenly been confronted with the fact that the market for advanced degrees has changed almost overnight. New Ph.D.'s in many fields, and especially in physics and some of the humanities, are learning to their dismay that

the jobs that they had expected to have awaiting them just as soon as they finished their degrees have already been filled, and apparently some new Ph.D.'s have gone unemployed for long periods. The probable effects of this change upon enrollments will be discussed in a later section. A detailed analysis of the future supply and demand for college teachers will be presented in a forthcoming paper.

As was pointed out earlier, most graduate students depend primarily for their support upon their own resources; only a small proportion of them obtain obligation-free stipends in the form of scholarships and fellowships. It would seem to follow that the "financial barrier" to graduate school entrance would be even more prohibitive to students from low-income families than it is at the undergraduate level. However, the available data do not substantiate this notion. Among graduate students surveyed by the Office of Education in 1965 (see [22]), 29% reported that, at the time that they were graduated from high school, their father's income was less than $5000 per year, and 56% said their father's income was less than $7500. Also, 42% of the graduate students reported their father's occupation to be in one of the classifications "laborer," "service worker," "semi-skilled operative," "skilled craftsman," or "farm operator," and 41% said that their fathers had not graduated from high school. Not only does this data contradict the assumption of a strong financial barrier between college graduation and graduate school entrance, it even suggests that poor students might be better represented among the graduate students than among the undergraduate students.

An NORC study of the graduating class of 1961 provides some further interesting information about the relationship between financial factors and graduate school entrance. It was reported in [3] that there was

virtually no difference between the enrollment pattern of those science students who had accumulated debts before entering graduate school and those who had not. Students with debts were slightly more likely to have delayed or interrupted their graduate studies during the three-year period from 1961 to 1964, but they were equally likely to have enrolled continuously, and they were less likely to have dropped out. Another surprising finding was that those graduate school entrants with undergraduate debts were only slightly less likely to be carrying heavy course loads than those without debts.

A commonly held misconception about graduate education in the U. S. is that only the top undergraduate students go on to graduate school. Spaeth and Greeley [14] report that about 60% of the college graduates of 1961 attended graduate school within seven years after graduation. With more than half of the graduating classes going on to graduate school, at least some of them had to rank below average in academic performance within their classes. As an indication of how little undergraduate performance is related to graduate school attendance, the 1965 Office of Education survey of graduate students cited above showed that 42% of the graduate students claimed undergraduate grade averages of B- or below, and only 17% had a grade average of A- or A. The worst undergraduate grade averages were reported by the graduate students in business and commerce, education, and the social sciences; the best by students in the humanities.

The data from Project TALENT enable one to compare "academic aptitude" test scores of those college graduates in the survey who entered graduate school with those who did not. As might be expected, those who went on to graduate school performed better on the tests, but the differences between

the two groups were surprisingly small. (See [12], p. 189.) These results suggest that few college graduates are permanently barred from graduate school on the basis of their academic records. On the other hand, this shallow examination of the overall ability level of graduate students may be misleading. Table 3 suggests that the proportion of students who are entering those fields usually considered to be more academically demanding, particularly the more mathematically oriented fields, has been steadily declining over the last ten years.

The preceding discussion has concentrated upon the developments in graduate education in the last ten years. For a comprehensive study of the historical development of graduate education up to 1960, including a variety of data on student and faculty characteristics, and discussions of degree programs, the reader is referred to Bernard Berelson's excellent treatise Graduate Education in the United States [2]. Berelson contends that graduate education has changed little in the last 50 years. In particular, the "current" criticisms of the doctoral program such as alleged overspecialization, the inappropriateness of the program as preparation for a career in college teaching, the lengthy duration of the program, the need for a new type of doctor's degree, and even the complaints about the obsolescence of the foreign language requirement have been voiced for decades. At the end of his book, Berelson lists 19 recommendations for improving graduate education and especially the Ph.D. program. Although written in 1960, his recommendations are almost as up-to-date and relevant today as they were then. Unfortunately, changes in graduate education seem to come about so slowly that his objectives may be almost as far from realization now as they were ten years ago.

A more recent analysis of the present status of graduate education, including a profound treatment of the issues mentioned above, is contained in Challenges to Graduate Schools by Ann Heiss [17]. In reporting the results of her comprehensive survey of graduate deans, department chairmen, faculty, and graduate students at ten major universities, Heiss has provided a penetrating exposé of how the graduate school operates at the departmental level. Her diagnosis of the shortcomings of graduate education today and her recommendations for the future merit immediate attention from the academic world. She has also collaborated with Anne Davis and Frank Voci to produce a very helpful annotated bibliography of graduate and professional education [18].

The issues in graduate education today, while of paramount importance to any complete treatment of the subject, bear only passing interest in this study of graduate enrollment patterns, because these patterns are more dependent on wartime, economic and demographic factors than upon academic ones. Even a broad acceptance of the Doctor of Arts degree and an unprecedented (and unlikely) universal effort to cut down the length of time required for earning doctor's degrees, as endorsed recently by the Carnegie Commission on the Future of Higher Education [8], would have little effect upon total graduate enrollment. For one thing, the proportion of graduate students who persist beyond the master's degree is not high at present, but any reduction in enrollments resulting from shortening the duration of doctoral programs would probably be more than offset by a corresponding increase in the number of students undertaking such programs. Also, past experience suggests that one can expect to wait a long time before seeing any changes of an academic nature in graduate education that would have an appreciable effect upon graduate enrollments.

ANALYSIS OF THE DATA ON GRADUATE ENROLLMENTS

The National Center for Educational Statistics routinely gathers data on first-time enrollments at the undergraduate level each year, but it has never attempted to count the number of new entrants at the graduate level. Thus, their data provide only indirect evidence about the proportion of bachelor's degree recipients who go on to graduate school, a matter of key importance in analyzing the flow of graduate students through the higher educational system. To get around this difficulty, we first turn to other sources of information about this matter.

There have been two extensive follow-up surveys of classes of college graduates, one the class of 1958 and the other the class of 1961. Although both of these studies had huge sample sizes and good response rates, their results may still have to be discounted slightly because of the potential for bias present in all surveys of educational attainment. In general, the respondents in such surveys tend to outperform the nonrespondents, and there is a certain amount of overreporting among the respondents.

The survey of the class of 1958 was conducted by the Bureau of Social Science Research under the direction of Laure Sharp [36]. This particular class may deserve special attention for historical reasons since it was the first class to graduate after the launching of Sputnik I. Among the 1958 graduates surveyed, 61% of the men and 53% of the women had undertaken some formal postbaccalaureate study before the summer of 1963. These percentages apparently include a large proportion of students who were not enrolled for advanced degrees; it was estimated that among those graduates in the survey, 41% of the men and 22% of the women were enrolled for advanced degrees (including professional degrees) within the five-year period after graduation, but the report states that these estimates may have been somewhat conservative.

Of those who were enrolled for advanced degrees, about 80% of the men and over 70% of the women were enrolled within two years after graduation.

The survey of the class of 1961 resulted in some surprising findings. Conducted by the National Opinion Research Center, this study (see [37]) consisted of three waves of questionnaires -- one, two and three years after the BA. In the first wave, 42.1% of the men and 25.1% of the women (35.1% of both sexes) said that they had enrolled for one or more courses in a program leading to a degree. In the second wave, 42.1% of the men and 26.7% of the women indicated that they had taken one or more courses leading to a degree during the second year after graduation. In the third wave, the proportions were 41.5% for men and 27.0% for women. Thus, the dropouts after each of the first and second years were almost exactly offset by late entrants and earlier dropouts who returned to graduate school, which provided an amazing stability in overall enrollment rates for this graduating class over the three-year period.

In 1968, NORC sent out still another wave of questionnaires to the class of 1961. Seven years after receiving their BA's, 17% of the respondents were still enrolled in graduate programs, and it was apparent from the responses that the persistent class of '61 would be well-represented on campus for many years to come. Spaeth and Greeley [14] summarized the 1968 data as follows:

> Three respondents in five had attended graduate school for some period, nearly half for a year or more, and a fifth for at least three years. A third held some kind of higher degree. Twenty-one percent had earned a master's, 10 percent a professional, and only 4 percent a doctoral degree. In contrast, one-sixth said that they planned to earn the doctorate, and over two-thirds reported the intention of earning some kind of advanced degree.

It is interesting to compare the actual enrollment performance of the class of '61 during this period with their aspirations for enrollment

at the time that they received their BA's as reported by Davis [10, p. 43]; 32.6% of the class had indicated their plans to attend graduate or professional school in the fall of 1961. This agrees closely with the 35.1% who actually reported enrollment sometime during the first year after graduation. Altogether, 77.2% had planned to attend graduate school sometime and 62.5% gave a specific year for beginning their programs; if about 60% actually entered within seven years, as the Spaeth and Greeley report suggests, then the aspirations of the class of '61, which must have sounded fantastic at the time, have come very close to being realized.

The two studies cited above also provide some information about the pattern of enrollment among graduate students. Among the graduate science students from the class of '61 who enrolled within three years after receiving their BA's, about 74% entered the first year, 16% the second year, and 10% the third year; only 45% of these students were enrolled for all three years, and 26% were enrolled during only one of the three years [3]. Among the graduate students from the class of '58 who enrolled within five years after graduation, approximately 78% had enrolled within the first two years [36]. If one can assume that the enrollment pattern was relatively stable during the post-Sputnik period up to 1965, it follows from the information above that the first-time graduate enrollment pattern for those who enrolled within five years after graduation must have been approximately as follows: about 65% enrolled during the first year after graduation, 14% during the second, 9% during the third, 7% during the fourth, and 5% during the fifth. These percentages for all graduate students match almost exactly the first-time enrollment pattern of the Ph.D.-recipients who received their degrees during the period 1964-1966; moreover, this pattern seems to have prevailed in most fields, except in the field of education where the average time-

lapse to first entry was considerably greater [21, p. 71].

The above percentages will be used to define a weighted average of the numbers of bachelor's degrees awarded during successive years for purposes of comparison with first-year graduate enrollment. Letting $b(t)$ denote the number of bachelor's degrees awarded in the academic year ending in year t, we define $x(t) = \Sigma_{k=0}^{4} a_k\, b(t-k)$ where $a_0=.65$, $a_1=.14$, $a_2=.09$, $a_3=.07$, and $a_4=.05$. As a measure of the "first-time graduate enrollment rate" in year t, we shall use the ratio $f(t) = n(t)/x(t)$, where $n(t)$ is the first-time graduate enrollment in year t. It is not essential that the weights a_k approximate the "true" situation with great precision in any given year, since the weighted averages $x(t)$ are not sensitive to small changes in the weights. There are no historical data available on the values of $n(t)$; these quantities will be estimated indirectly below from the data on first-year enrollments for advanced degrees. The historical data on numbers of bachelor's degrees and the values of $x(t)$ for the years 1955-1969 are given in Table 6. The sources of the data on bachelor's degrees are given in the appendix.

In the sequel, the following notation will also be used:

$g(t)$ = enrollment for advanced degrees during year t,

$g_i(t)$ = enrollment for advanced degrees during year t at the i^{th} level ($i = 1,2,3$ to correspond to first-year, intermediate, and terminal year levels respectively),

$n(t)$ = number of new graduate students among the enrollees for advanced degrees during year t,

$r_i(t)$ = number of students enrolled at the i^{th} level during year t who are neither new students nor enrollees during year $t-1$ at the same or preceding level,

$p_{ij}(t)$ = proportion of students enrolled at the i^{th} level during year $t-1$ who re-enrolled at the j^{th} level during year t.

The first-year enrollment $g_1(t)$ consists of the new students during year t, the returning students from the previous year who have not completed one full year of graduate level work, and others. Therefore, $g_1(t)$ satisfies the equation

(1) $$g_1(t) = n(t) + p_{11}(t)\, g_1(t-1) + r_1(t).$$

Equations (2) and (3) represent the analogous breakdown of the intermediate and terminal year enrollments.

(2) $$g_2(t) = p_{12}(t)\, g_1(t-1) + p_{22}(t)\, g_2(t-1) + r_2(t)$$

(3) $$g_3(t) = p_{23}(t)\, g_2(t-1) + p_{33}(t)\, g_3(t-1) + r_3(t)$$

(4) $$g(t) = g_1(t) + g_2(t) + g_3(t)$$

These equations hold for both men and women separately, and the analysis below will treat the two sets of equations separately, even though this is not expressed explicitly in the notation. As needed below, notation such as $g_1^m(t)$ and $g_1^w(t)$, for example, will be used to denote the first-year enrollments for men and women respectively.

The only "known" values in equations (1) - (4) above are the values of $g_i(t)$ and $g(t)$. In order to cut down the number of unknowns, it is convenient to reparameterize equations (1) - (3) to eliminate the unobservable quantities $r_i(t)$. From the definition of $r_i(t)$, it seems reasonable to assume that the values of $r_i(t)$ are approximately proportional to the quantities $g_i(t-1)$, say $r_i(t) \doteq c_i\, g_i(t-1)$. (This assumption is not verifiable, and it is not even essential to the reparameterization below, but it helps to provide meaning to the quantities γ_i to be introduced

below.) This assumption leads us to "absorb" the terms $r_i(t)$ in the equations (1) - (3) above into the terms involving $g_i(t-1)$ to yield equations (5) - (7) below:

$$(5) \qquad g_1(t) = n(t) + \gamma_1(t)\, g_1(t-1)$$

$$(6) \qquad g_2(t) = p_{12}(t)\, g_1(t-1) + \gamma_2(t)\, g_2(t-1)$$

$$(7) \qquad g_3(t) = p_{23}(t)\, g_2(t-1) + \gamma_3(t)\, g_3(t-1).$$

This replaces the "repeat rates" $p_{ii}(t)$ by the quantities $\gamma_i(t)$, which will be called the "modified repeat rates." These quantities are defined by equations (5) - (7); e.g., $\gamma_1(t) = [g_1(t) - n(t)] / g_1(t-1)$, which is the ratio of the number of returning students at the first level during year t to the number of students at the first level during year $t-1$. It is convenient to use the assumption above that $r_i(t) \doteq c_i\, g_i(t-1)$ to exhibit an approximate relationship between the modified repeat rates $\gamma_i(t)$ and the true repeat rates, namely,

$$(8) \qquad \gamma_i(t) \doteq p_{ii}(t) + c_i.$$

It was shown in [15] that there has been an amazing stability in the retention rates at the undergraduate level over the past 25 years and perhaps even longer. This leads us to expect that there might be a similar stability at the graduate level. If so, then the repeat rates $p_{ii}(t)$ and the advancement rates $p_{ij}(t)$ should be approximately stable over time, and by (8) so should the modified repeat rates $\gamma_i(t)$.

To check this conjecture, one would like to be able to compute the ratio $Q(t) = [g(t) - n(t)] / g(t-1)$ for each year t, which is an index of overall retention for all three levels combined. Although there is no data available on the number of new graduate students $n(t)$ for any year t, it seems safe to assume that the proportion of new students among the

first-year students has been relatively stable over the past 15 years, so that $n(t) \doteq c\, g_1(t)$. This leads us to check for stability in the retention rates by computing ratios of the form prescribed above with $n(t)$ replaced by $c\, g_1(t)$, using several different values of c. See Table 5.

The table indicates that, for the choices of the constant c within the right range, the overall retention rates have remained virtually unchanged during the past ten years. This conclusion will be used to suppress the dependence of the modified repeat rates $\gamma_i(t)$ on the time variable t in equations (5) - (7) to the single parameters γ_i, which will be estimated below from the data.

A further analysis of the data suggests that the advancement rates $p_{12}(t)$ have also been relatively stable during the past ten years for both sexes, and $p_{12}(t)$ will be replaced by a time-independent parameter α_2 in equations (8) - (10) below. However, the data on intermediate and terminal year enrollments provide some rather strong evidence that the advancement rates $p_{23}(t)$ from the intermediate level to the terminal year level have been increasing slightly but steadily (and approximately linearly) over the past ten years for both men and women. This and other evidence to be given below lead to the conclusion that the proportion of graduate school entrants who go on to earn Ph.D's has been increasing during the past ten years. This does not invalidate the earlier premise that the overall retention rates at the graduate level have been relatively stable, because the rate of increase has been small and the proportion of the entering graduate students who eventually finish Ph.D.'s is also quite small -- perhaps between 15% and 20% of the men and about 5% of the women. Incorporating the assumptions above into equations (5) - (7) above leads to the following equations:

Table 5

Values of the Overall Retention Indices
$Q(t) = [g(t) - cg_1(t)] / g(t-1)]$ by Sex, 1960-1969

Year t	c = .5			c = .6			c = .8		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
1969	.736	.702	.725	.673	.618	.655	.547	.449	.514
1968	.742	.708	.731	.679	.620	.660	.554	.446	.520
1967	.763	.710	.747	.696	.622	.674	.563	.445	.527
1966	.742	.687	.726	.675	.602	.653	.540	.431	.508
1965	.763	.703	.745	.693	.615	.670	.554	.438	.520
1964	.768	.708	.751	.699	.620	.676	.560	.443	.527
1963	.760	.702	.744	.693	.616	.672	.559	.444	.527
1962	.764	.709	.749	.698	.624	.678	.567	.454	.536
1961	.755	.672	.733	.691	.591	.664	.561	.429	.525
1960	.744	.673	.725	.681	.593	.657	.554	.431	.521

(8) $$g_1(t) = n(t) + \gamma_1 g_1(t-1) + e_1(t)$$

(9) $$g_2(t) = \alpha_2 g_1(t-1) + \gamma_2 g_2(t-1) + e_2(t)$$

(10) $$g_3(t) = [\alpha_3 + \beta_3(t-1961)] g_2(t-1) + \gamma_3 g_3(t-1) + e_3(t).$$

The quantities $e_i(t)$ in these equations represent small unobserved deviations to account for "lack of fit" in the model resulting from replacing the modified repeat rates and advancement rates by the parameters introduced above and from errors in estimating the enrollments $g_i(t)$.

Now let us consider the numbers of new graduate students $n(t)$, for which no historical data are available. Using the definition of the first-time graduate enrollment rate given earlier, namely $f(t) = n(t)/x(t)$, we have that $n(t) = f(t)\, x(t)$. Hence, to estimate $n(t)$, it suffices to estimate $f(t)$, since the past values of $x(t)$ are known. To get a rough idea of how the enrollment rates $f(t) = n(t)/x(t)$ have behaved in the past, one can use the ratios $g_1(t)/x(t)$, which are approximately proportional to the enrollment rates $f(t)$ because the values $n(t)$ are approximately proportional to the first-year enrollments $g_1(t)$. T he values of $b(t)$, $x(t)$, and $g_1(t)/x(t)$ are given in Table 6. The ratios $g_1(t)/x(t)$ indicate that the graduate enrollment rates $f(t)$ rose sharply and approximately linearly from 1960 to 1965 for both men and women.

To estimate the first-time graduate enrollment $n(t)$ and thereby estimate the first-time enrollment rate $f(t)$, it suffices to estimate the parameter γ_1 in equation (8) and solve (8) for $n(t)$, ignoring the error term $e_1(t)$, which is small relative to $g_1(t)$. This leads us to estimate $n(t)$ and $f(t)$ by $\hat{n}(t) = g_1(t) - \hat{\gamma}_1 g_1(t-1)$ and $\hat{f}(t) = \hat{n}(t)/x(t)$, where $\hat{\gamma}_1$ is the estimated value of γ_1.

Table 6

Bachelor's Degrees, Estimated First-time Graduate Enrollment, and Enrollment Rates, 1955-1969
(data in thousands)

Year t	Bachelor's degrees $b(t)$		Weighted average $x(t)$		Ratio $\frac{g_1(t)}{x(t)}$		Est. first-time enrollment rate $\hat{f}(t)$		Est. first-time grad. enrollment $\hat{n}(t)$	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
1969	411	318	381	293	.774	.675	.498	.456	190	133
1968	358	275	337	265	.824	.697	.522	.477	176	122
1967	323	236	307	225	.877	.697	.566	.480	174	108
1966	299	221	285	210	.887	.646	.575	.436	164	92
1965	278	211	266	198	.883	.622	.585	.427	156	85
1964	262	196	250	181	.839	.590	.559	.409	140	74
1963	238	170	233	160	.797	.573	.527	.394	123	63
1962	227	153	225	146	.740	.547	.484	.374	109	55
1961	222	141	219	135	.692	.523	.450	.349	99	47
1960	219	134	214	129	.655	.508	.424	.340	91	44
1959	221	126	210	121	.626	.500	.414	.340	87	41
1958	210	118	197	114	.597	.470	.401	.323	79	37
1957	191	113	181	110	.565	.428	.360	.280	65	31
1956	169	107	166	105	.591	.433	.390	.292	65	31
1955	153	100	161	100	.547	.412	.350	.268	56	27

The methodology for estimating γ_1 and the other parameters in equations (8) - (10) from the data in Table 3 is discussed in the appendix. The resulting "fitted equations" are given below, and the estimated graduate enrollment rates and first-time graduate enrollments are given in Table 6. For men:

$$(11) \qquad g_1(t) = \hat{f}(t)\, x(t) + .378\, g_1(t-1)$$

$$(12) \qquad g_2(t) = .221\, g_1(t-1) + .680\, g_2(t-1)$$

$$(13) \qquad g_3(t) = [.096 + .005(t-1961)]\, g_2(t-1) + .322\, g_3(t-1).$$

For women:

$$(14) \qquad g_1(t) = \hat{f}(t)\, x(t) + .359\, g_1(t-1)$$

$$(15) \qquad g_2(t) = .196\, g_1(t-1) + .450\, g_2(t-1)$$

$$(16) \qquad g_3(t) = [.031 + .005\ (t-1961)]\, g_2(t-1) + .362\, g_3(t-1).$$

A plot of the estimated first-time graduate enrollment rates is given in Figure 2. It shows that the enrollment rates for men rose sharply up to 1965 and then decreased slightly in 1966 and 1967 in conjunction with the troop buildup in Vietnam. The severe drops during the past two years only reveal part of the effect of changes in Selective Service policies, because the losses in numbers of new graduate students due to the draft have been offset in part by the increasing numbers of veterans and foreign students who entered the graduate school during this period. As a result of the four-year decline in the enrollment rates for men, the 1969 rate is far below the 1965 high, and one can expect at least a partial recovery within the next year or two.

The enrollment rates for women during the post-Sputnik era increased steadily and almost as rapidly as the rates for men up to 1965. In 1967

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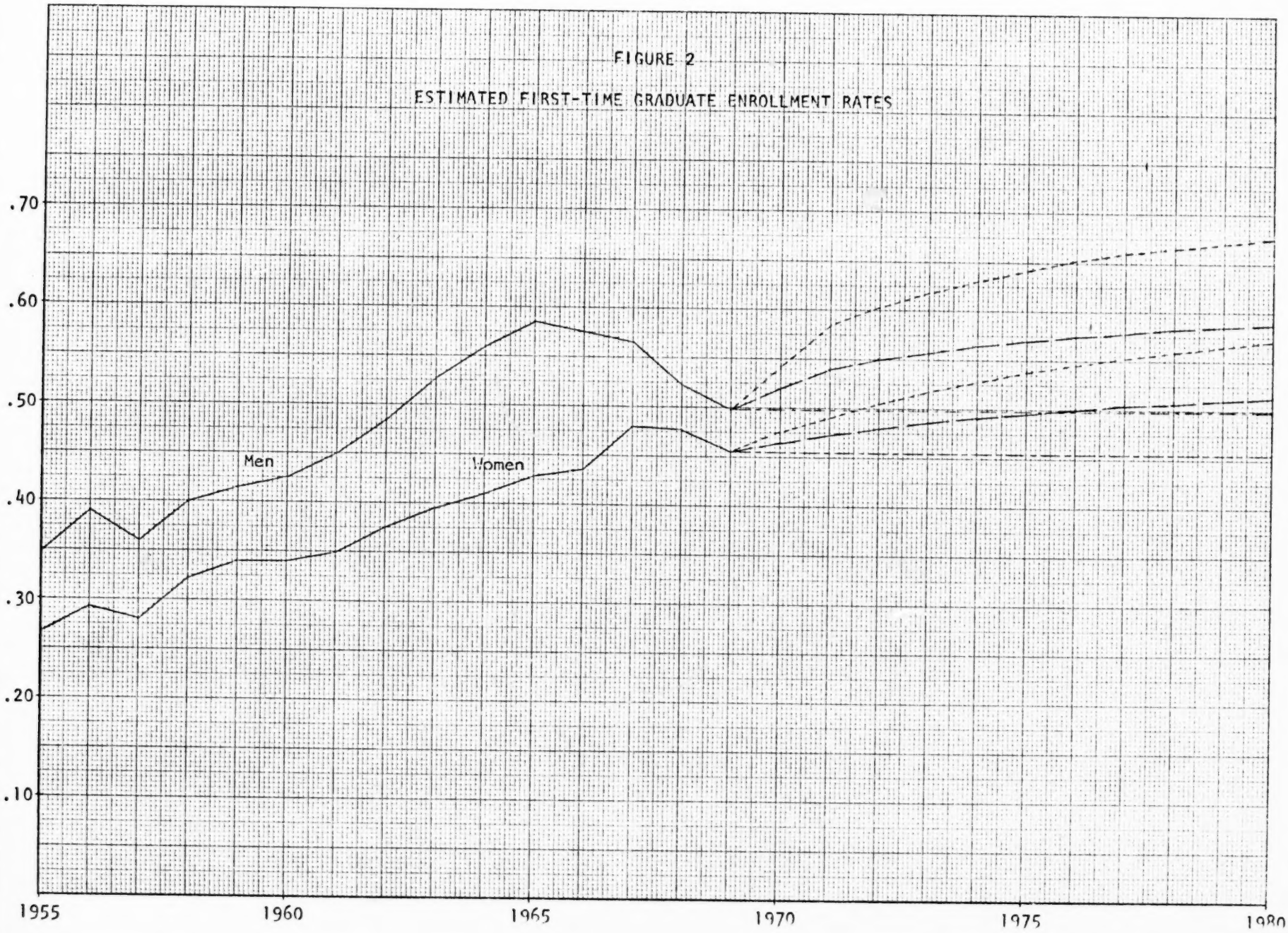
FIGURE 2

ESTIMATED FIRST-TIME GRADUATE ENROLLMENT RATES



the rate for women took a jump upward, partially counterbalancing the drop in the enrollment rate for men during the Vietnam buildup. Perhaps the drop in the estimated enrollment rates in 1969 for women merely represents a return to equilibrium after the spurt in 1967 and 1968, but it may be the first indication that the tightening job market, especially for teachers, is beginning to affect graduate enrollment rates for women.

The dotted lines in Figure 2 indicate some possible future enrollment rate trends that will be used below in providing three series of graduate enrollment projections.

PROJECTIONS OF GRADUATE ENROLLMENTS

A key question in making long-term projections of graduate enrollments is: How much higher can the enrollment rates go? Since the survey of the class of 1961 sheds some light on this question, it is necessary to establish the correspondence between the estimated enrollment rates given here and the enrollment rates that resulted from the survey.

To do this, we first need to deflate our enrollment rates slightly to account for the inclusion of foreign students in the enrollments. In 1963 there were 23,000 men and 5,000 women from foreign countries [23, p. 111] among the 334,000 men and 144,000 women in the graduate resident enrollment, so that the percentages of foreign students were 6.9% and 3.5% for men and women respectively. Deflating the estimated enrollment rates for 1961 by these percentages reduces them from 45% to 42% for men and from 35% to 34% for women. It is important to remember that these figures exclude the first-professional students and the "unclassified students" who take graduate level courses but are not enrolled in a degree program. In 1968, the total postbaccalaureate enrollment exceeded the enrollment for advanced degrees (excluding the first-professional students) by 49% for men and 46% for women. If the total postbaccalaureate enrollment in 1961 exceeded the enrollment for advanced degrees by the same margin for each sex, this would bring the overall postbaccalaureate enrollment rates for 1961 to 63% for men and 50% for women. This result agrees almost perfectly with the NORC finding cited earlier that about three-fifths of the graduating class of 1961 had undertaken some graduate work within seven years after graduation. Since the survey probably over-estimates the true proportions somewhat, perhaps these estimates should be

deflated slightly, say to around 60% for men and 47% for women. If so, then the overall postbaccalaureate enrollment rates for 1961 exceed the first-time enrollment rates by about one-third for both men and women.

Applying the same adjustment factor to the estimated first-time enrollment rate for 1965, when the rate for men reached a high of 58.5%, would lead to estimating overall postbaccalaureate enrollment rates for American college graduates to be between 75% and 80% for men and between 60% and 65% for women. However, since student deferments in 1965 were contingent upon enrollment in degree programs, a higher proportion of the male graduate students were probably enrolled in degree programs so that the adjustment by one-third may provide an overestimate of the overall male enrollment rate. Nevertheless, the conclusion is clear: the enrollment rates for men were already close to their saturation point in 1965.

It is interesting to compare the estimates above for the graduating class of 1965 with those reported by Alexander Astin and Robert Panos in [1], which resulted from a survey of the freshman class in the fall of 1961 and a follow-up study of the same students in the summer of 1965. Among the students in the follow-up survey who had already completed or who intended to complete a bachelor's degree, 77% of the men and 72% of the women indicated future plans to complete a postbaccalaureate degree [1, p. 33]. Despite the near equality of these proportions for men and women, Astin and Panos noted some striking differences between the sexes in educational aspirations, especially in their plans for pursuing a doctoral program:

> Even though nearly equal proportions of the two sexes said that they would obtain some sort of graduate degree, nearly twice as many women as men were not sure when they would actually receive it. The sexes differed also in the level of graduate degree they planned to obtain, with one-third of the men, as compared with less

> than 10 percent of the women, aspiring to doctoral-level or professional degrees (Ph.D. or Ed.D., medical degrees, law degrees, etc.). Women were much more likely to be pursuing the master's degree, a trend which in part reflects their much higher concentration in the field of education.

These aspirations for educational attainment, especially the high proportions of those who aspire to complete doctor's degrees, may seem somewhat unrealistic; indeed, the effects of the Vietnam War and the job outlook for holders of advanced degrees may already have quashed the possibility of such achievements. On the other hand, the aspirations for graduate enrollment of the class of 1961 as reported by Davis [10] also must have sounded fantastic at the time, and those aspirations came very close to being realized.

A further consideration in estimating how much higher the first-time enrollment rates can go is that enrollment for master's and doctor's degrees has increased more rapidly than enrollment for first-professional degrees in the past, and the proportion of students enrolled in degree programs may increase. Therefore, the ratio of enrollment for advanced degrees (excluding first-professional degrees) to total postbaccalaureate enrollment may increase in the long run. Also, the proportion of foreign students has been rising in the last few years, and this factor may become more significant over time.

After considering the above, this writer believes that the first-time enrollment rates for men, after a readjustment period during the next two to four years to return to (and perhaps exceed) the 1965 level as the veterans return to the campuses, will begin to level off and tend toward an asymptote between 60% and 75%. (See Figure 2.) After the readjustment period, the women's enrollment rates can be expected to parallel those for men with perhaps some narrowing of the wide gap between them that existed in the 1963-1965 period.

Three sets of projections of enrollment for advanced degrees by level and sex are provided in Tables 7a-c. All three use the "fitted equations" (11) - (16) but with different sets of first-time enrollment rates $f(t)$ and with certain modifications of equations (13) and (16) for projecting terminal-year enrollments.

Projections A. Here it is assumed that the first-time graduate enrollment rate $f(t)$ for men will return to its 1965 high in two years as draft calls decrease and the numbers of veterans increase. Thereafter, the enrollment rate will tend to an asymptote of 70% following a curve $f(t) = .7 - a\,e^{-b(t-1971)}$, where a and b are chosen so that the rate for 1971 agrees with the 1965 rate and the curve $f(t)$ has slope .02 beginning in 1971. For women the enrollment rate is assumed to tend to an asymptote of 60% following a curve $f(t) = .6 - a\,e^{-b(t-1969)}$ where a and b are chosen so that the rate for 1969 agrees with the estimated rate for 1969 and $f(t)$ has slope .02 beginning in 1969. The slope .02 is chosen since it agrees with the estimated growth rate in the enrollment rates for women during the period 1960-1968. The projected enrollment rates under Projection A are represented by the uppermost dotted lines for both sexes in Figure 2. Projections A are then generated by combining these projected enrollment rates into equations (11) - (16) with the projected numbers of college graduates given in the appendix. A slight departure from this scheme that only affects projected enrollments after 1980 results from the assumption that the advancement rates between the intermediate and terminal years, estimated t o increase linearly at a rate of 0.5% per year for both sexes according to equations (13) and (16), will level off beginning in 1980.

Table 7a

Projections A of Graduate Resident Enrollment, Enrollment for Advanced Degrees, and Postbaccalaureate Enrollment in the United States, 1970-2000
(All data are in thousands)

Year	Graduate resident enrollment			Enrollment for advanced degrees									Postbaccalaureate enrollment		
				All levels			First-year		Intermediate		Terminal year				
	Men	Women	Total	Men	Women	Total	Men	Women	Men	Women	Men	Women	Men	Women	Total
1970	610	360	970	540	290	830	330	220	180	65	33	8	800	420	1220
1971	680	390	1070	600	320	920	370	240	190	72	37	10	880	450	1330
1972	750	430	1180	670	360	1030	410	270	220	80	42	12	960	500	1460
1973	820	480	1300	740	390	1130	450	290	240	88	47	14	1050	550	1600
1974	890	520	1410	800	430	1230	480	320	260	96	54	16	1130	600	1730
1975	970	570	1540	860	470	1330	520	340	280	110	61	19	1210	650	1860
1976	1040	620	1660	930	510	1440	560	370	310	120	68	22	1300	700	2000
1977	1110	660	1770	990	550	1540	580	400	330	120	77	25	1370	750	2120
1978	1180	700	1880	1050	580	1630	610	420	360	130	85	28	1440	790	2230
1979	1240	740	1980	1100	610	1710	630	440	380	140	94	32	1510	830	2340
1980	1290	780	2070	1150	650	1800	650	460	400	150	100	36	1560	880	2440
1985	1490	930	2420	1330	770	2100	730	540	470	180	130	49	1750	1020	2770
1990	1480	920	2400	1320	760	2080	690	520	490	190	140	55	1740	1010	2750
1995	1500	960	2460	1340	790	2130	720	550	480	190	140	54	1790	1060	2850
2000	1680	1110	2790	1500	910	2410	830	640	530	210	140	58	2010	1230	3240

Table 7b

Projections B of Graduate Resident Enrollment, Enrollment for Advanced Degrees and Postbaccalaureate Enrollment in the United States, 1970-2000
(All data are in thousands)

Year	Graduate resident enrollment			Enrollment for advanced degrees									Postbaccalaureate enrollment		
				All levels			First-year		Intermediate		Terminal year				
	Men	Women	Total	Men	Women	Total	Men	Women	Men	Women	Men	Women	Men	Women	Total
1970	600	350	950	530	290	820	320	220	180	65	32	8	790	410	1200
1971	650	380	1030	580	310	890	350	230	190	72	35	9	850	440	1290
1972	700	420	1120	630	340	970	380	250	210	78	38	10	920	480	1400
1973	760	450	1210	680	370	1050	410	270	230	85	41	11	980	520	1500
1974	810	490	1300	720	400	1120	440	300	240	92	44	12	1050	560	1610
1975	860	530	1390	770	430	1210	460	320	260	100	48	13	1110	600	1710
1976	920	570	1490	820	470	1290	490	340	280	110	51	14	1170	650	1820
1977	970	600	1570	870	490	1360	510	360	300	110	55	16	1230	680	1910
1978	1020	630	1650	910	520	1430	530	380	320	120	59	17	1280	720	2000
1979	1060	660	1720	950	550	1500	550	400	340	130	62	18	1330	750	2080
1980	1100	690	1790	990	570	1560	570	410	350	140	66	19	1380	780	2160
1985	1250	810	2060	1120	660	1780	630	480	410	160	80	24	1510	900	2410
1990	1230	790	2020	1100	650	1750	590	460	420	170	86	27	1490	880	2370
1995	1240	820	2060	1110	680	1790	620	480	410	170	83	26	1540	920	2460
2000	1400	950	2350	1250	780	2030	710	560	450	190	88	29	1730	1070	2800

Table 7c

Projections C of Graduate Resident Enrollment, Enrollment for Advanced Degrees, and Postbaccalaureate Enrollment in the United States, 1970-2000
(All data are in thousands)

Year	Graduate resident enrollment			Enrollment for advanced degrees								Postbaccalaureate enrollment		
				All levels			First-year		Intermediate		Terminal year				
	Men	Women	Total	Men	Women	Total	Men	Women	Men	Women	Men	Women	Men	Women	Total
1970	590	350	940	520	290	810	310	210	180	65	32	8	780	410	1190
1971	620	370	990	550	310	860	330	230	190	71	35	9	820	440	1260
1972	660	400	1060	590	330	920	350	240	200	76	37	10	870	470	1340
1973	700	430	1130	620	350	970	370	260	210	82	40	11	920	500	1420
1974	730	460	1190	660	380	1040	390	280	230	88	42	12	970	530	1500
1975	770	490	1260	690	400	1090	410	290	240	94	45	13	1020	570	1590
1976	820	520	1340	730	430	1160	430	310	250	100	47	14	1070	600	1670
1977	850	550	1400	760	450	1210	440	330	270	110	50	15	1110	630	1740
1978	890	570	1460	790	470	1260	460	340	280	110	53	16	1150	660	1810
1979	920	600	1520	820	490	1310	470	360	290	120	55	17	1190	690	1880
1980	950	620	1570	840	510	1350	480	370	300	120	58	18	1220	710	1930
1985	1060	710	1770	950	580	1530	530	420	350	140	68	22	1320	800	2120
1990	1030	690	1720	920	570	1490	500	400	350	150	72	24	1290	780	2070
1995	1040	710	1750	930	580	1510	510	420	350	140	70	23	1330	820	2150
2000	1160	820	1980	1040	670	1710	590	490	380	160	74	25	1500	940	2440

Projections B. For this set, it is assumed that the first-year enrollment rates $f(t)$ will increase at one-half the rate assumed under Projections A and will tend to asymptotes midway between the estimated rates for 1969 and the asymptotes prescribed under Projections A. These projected enrollment rates are represented by the middle set of dotted lines in Figure 2.

Another change from Projections A is that the advancement rates between the intermediate and terminal years are not assumed to increase beyond their estimated levels for 1969. This is tantamount to assuming that the proportion of graduate students who persist into the terminal year of doctoral study will not increase beyond the 1969 level.

Projections C. For these projections, it is assumed that both the enrollment rates and the advancement rates will remain at their estimated 1969 levels. Thus, the only increases in enrollment according to these projections are those resulting from the growth of the numbers of college graduates.

For all three sets of projections, the graduate resident enrollments result from applying a constant factor to the projections of total enrollment for advanced degrees, where the constant factor is taken to be the observed ratio of these enrollments in 1968. The postbaccalaureate enrollment projections result from adding the graduate resident enrollment projections to projections of graduate extension and first-professional enrollments, which are assumed to rise at the same rate as the projections of total undergraduate, first-professional, and graduate extension enrollments given in [15].

Projections A would represent this writer's best guess of the enrollment pattern during the next ten or twenty years if it were not for the unpredictable

effects upon future graduate enrollments of the expected continued reduction in the demand for holders of advanced degrees, especially in the teaching field. Under these projections, the expected post-Vietnam enrollment surge during the next few years will more than offset the declines of the past few years. Projections B represent an attempt to deflate Projection A to account for a possible reduction in graduate enrollment rates as a consequence of a reduced demand for highly trained manpower. This possibility will be considered further below. Projections C are included for purposes of providing a possible lower bound for long-term projections, but the vagaries of the factors mentioned above as well as the uncertainties associated with such factors as the increasing dissatisfaction on the part of the students with graduate education and the ominous forebodings that the state governments will also drop their levels of support for graduate education may very well combine to hold enrollments below the levels of these projections for the next year or two. Also, it must be recognized that the shortcomings of the past data on graduate enrollments are such that reliable projections would be impossible even if these other factors were not present.

According to Projections A, postbaccalaureate enrollment will double between 1970 and 1980 -- from about 1.2 million in 1970 to around 2.4 million in 1980. As can be seen by comparison with Projections C, where constant enrollment and retention rates are assumed, about 60% of the growth under projections A would be attributable to the increased sizes of the college graduating classes and the rest to increased enrollment and retention rates, including the post-Vietnam adjustment.

Both Projections A and B indicate higher growth rates for graduate enrollments than those implied by recent projections of NCES in [25]. In fact, the NCES projections of graduate resident enrollment run lower

than those in Projections C, but this results in part from their having used preliminary estimates of 1968 enrollments that proved to be too low. Their projections indicate that graduate resident enrollment will rise by 59% between 1970 and 1978, as compared with 74% under Projections B and 55% under Projections C.

The increases in enrollment rates under both Projections A and B are based entirely upon the presupposed increasing student demand for graduate education (and, of course, many other factors which have not been mentioned, such as the absences of future wars, national catastrophe, political revolution, and economic depression). Perhaps this supposition, which would have gone unchallenged until very recently, now deserves further attention in the light of certain evidence that graduate education may have lost some of its earlier appeal among the current generation of college students. Among Harvard seniors, the proportion planning to undertake graduate study has dropped from 74% in 1967 to 46% in 1970 [33]. At the University of Illinois, the proportion dropped from 48% in 1969 to 37% in 1970 [34]. Helen Astin recently reported that the proportion of entering college freshmen who said they planned to earn a doctorate has declined from 13.7% in 1966 to 12.3% in 1970 [35]. Whether these reports are related to economic factors is not clear since, in the Illinois study, the proportion of seniors who planned to study medicine or law also dropped, from 17.3% in 1969 to 15.9% in 1970; among students majoring in French, 70% planned to enter graduate school, despite the warnings of an overabundance of college teachers in this field.

Another underlying assumption is that there will be a continuing desire and capability on the part of the institutions to expand graduate education

at a rapid rate. In the end, this depends upon a continuing willingness on the part of the public to finance the rapid expansion of the very costly graduate programs, but even the educators are questioning the justification for these huge expenditures.

According to a recent survey by Lewis Mayhew, the institutions themselves appear to be preparing to absorb future enrollments at a rate approximately that indicated by Projections A. The 400 institutions responding to his survey indicated that graduate enrollments at these institutions would approximately double between 1968 and 1980 [20, p. 12]. This is slightly less than the rate of increase of Projections A, but his survey results exclude enrollments at institutions which will be offering graduate level work for the first time between 1968 and 1980. As will be seen below, the estimates of doctorate production in 1980 derived from Mayhew's survey are close to those in Projections B.

A finding of Mayhew's survey that some have found disquieting is that the greatest rate of growth in graduate enrollments will take place in the developing institutions and primarily in the public institutions. Mayhew estimates that an additional 140 to 160 institutions will begin offering doctoral programs between 1968 and 1980 [20, p. 2], but there is considerable concern that this will lead to a depreciation of standards in doctoral programs. (Undoubtedly, there was a similar concern among academicians at Johns Hopkins, Harvard, Columbia, and Yale in the latter half of the 19th century as graduate enrollments proliferated at such emerging institutions as the Universities of California, Wisconsin, and Illinois.) At any rate, it seems clear that future increases in graduate enrollments will not be shared uniformly among the existing institutions; the more prestigious institutions, especially the private ones, will carry a smaller proportion of the burden.

ADVANCED DEGREE PRODUCTION

Table 8 gives the numbers of master's and doctor's degrees awarded from 1955 to 1970. The sources of the data are given in the appendix. The definitions of the terms "doctor's degree" and "master's degree" used here are those used in the NCES reports on earned degrees (See [24].) In particular, the term "doctor's degree" includes a Ph.D. in any field and degrees such as doctor of education and doctor of juridical science but excludes first-professional degrees as in medicine, dentistry, law, and theology. The term "master's degree" was redefined in 1965-66 to include some degrees previously classified as first-professional.

The ratios given in Table 9 show how rapidly degree production has been rising relative to enrollments in certain categories. Here, $m(t)$ and $d(t)$ denote the numbers of master's and doctor's degrees awarded during the academic year ending in year t. One would expect the ratio of $d(t)$ to $g_3(t-1)$, the terminal year enrollment during the fall term of the same year, to be nearly constant over time, but the ratios in Table 9 show a peculiar behavior. An examination of these ratios by field suggests that the high values of these ratios in 1965 and 1966 may result from underestimates of terminal year enrollments in certain fields. The ratios of $d(t)$ to $\Sigma_{k=4}^{7} \hat{n}(t-k)/4$ and to $\Sigma_{k=4}^{7} g_1(t-k)/4$ compare the numbers of doctor's degrees in each year t to the average first-time and first-year enrollments for advanced degrees during the preceding 4 to 7 years. These ratios indicate that the proportion of entering graduate students who complete doctoral programs has been increasing slightly but steadily for the last ten years. The values of these ratios for 1970 --

Table 8

Master's and Doctor's Degrees Awarded
in the United States, 1955-1970

Year	Master's Degrees			Doctor's Degrees		
	Men	Women	Total	Men	Women	Total
1970	---	---	---	25,900	4,000	29,900
1969	121,531	72,225	193,756	22,752	3,436	26,188
1968	113,519	63,230	176,749	20,183	2,906	23,089
1967	103,090	54,616	157,706	18,163	2,454	20,617
1966	93,063	47,492	140,555	16,121	2,116	18,237
1965	76,161	35,963	112,124	14,692	1,775	16,467
1964	68,969	32,081	101,050	12,955	1,535	14,490
1963	62,911	28,455	91,366	11,448	1,374	12,822
1962	58,686	26,169	84,855	10,377	1,245	11,622
1961	54,129	24,099	78,228	9,463	1,112	10,575
1960	50,898	23,537	74,435	8,801	1,028	9,829
1959	47,389	22,170	69,559	8,371	989	9,360
1958	44,229	21,357	65,586	7,978	964	8,942
1957	41,329	20,611	61,940	7,817	939	8,756
1956	39,393	19,888	59,281	8,018	885	8,903
1955	38,739	19,461	58,200	8,014	826	8,840

Table 9

Ratios of Degree Production to Enrollments in Certain Categories, 1960-1970

Year	$\frac{m(t)}{\hat{n}(t-2)}$		$\frac{m(t)}{g_1(t-1)+g_2(t-1)}$		$\frac{d(t)}{g_3(t-1)}$		$\frac{d(t)}{\sum_{k=4}^{7} \hat{n}(t-k)/4}$		$\frac{d(t)}{\sum_{k=4}^{7} g_1(t-k)/4}$	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
1970	---	---	---	---	.863	.628	.178	.051	.117	.035
1969	.700	.667	.277	.316	.786	.637	.173	.050	.114	.034
1968	.693	.690	.271	.316	.829	.695	.172	.049	.113	.033
1967	.663	.646	.269	.314	.869	.722	.173	.047	.113	.032
1966	.665	.641	.260	.302	.954	.846	.167	.045	.109	.031
1965	.621	.569	.236	.262	.954	.807	.165	.042	.109	.028
1964	.634	.588	.238	.271	.912	.853	.161	.040	.105	.027
1963	.637	.602	.237	.273	.923	.916	.155	.039	.102	.027
1962	.646	.597	.242	.285	.865	.958	.156	.040	.102	.027
1961	.624	.587	.242	.284	.809	.855	.156	.039	.101	.026
1960	.645	.637	.241	.300	.786	.857	.159	.039	.102	.025

17.8% for men and 5.1% for women -- provide estimates (perhaps slightly inflated) of the proportion of entering students who complete doctoral programs. Thus, the successful doctoral candidates comprise only a small proportion of total graduate enrollment.

The projections of doctor's degrees in Table 10 result from consideration of the ratios $d(t) / [\Sigma_{k=4}^{7} g_1(t-k)/4]$, which have been increasing at a rate of about .002 per year for men and .001 per year for women for the last five years, as can be seen from Table 9. Under Projections A, it is assumed that these ratios will continue to increase at the same rates until 1980 and will then level off. Under Projections B, it is assumed that the ratios will increase at one-half the rates specified under Projections A. Under Projections C, it is assumed that the ratios will remain at their 1970 levels. The projections of master's degrees in Table 10 result from the assumption that the ratio of the number of master's degrees to the combined total of first-year and intermediate enrollments for advanced degrees will remain stable at 28% for men and 32% for women. As indicated in Table 9, these ratios have changed little during the last ten years except for the jump in 1966 resulting from the reclassification of degrees. For each set of projections, the assumptions above are applied to the corresponding sets of projections of enrollments for advanced degrees given in Tables 7a-c.

According to Projections A, which represent anticipated future degree production based upon past trends and certain assumptions about the post-Vietnam enrollment rates, the number of doctor's degrees awarded will double between 1970 and 1977. Under Projections C, which should provide a lower bound for future degree production, the number of doctor's degrees

Table 10

Projections of Master's and Doctor's Degrees
in the United States, 1970-2000
(All data are in thousands)

Year	Projections A			Projections B			Projections C		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
MASTER'S DEGREES									
1970	129	82	211	129	82	211	129	82	211
1971	143	91	234	140	90	230	138	89	227
1972	159	100	259	152	98	250	145	95	240
1973	175	110	285	165	106	271	154	102	256
1974	192	121	313	178	115	293	163	109	272
1975	208	133	341	190	125	315	172	117	289
1976	225	144	369	203	135	338	181	125	306
1977	242	156	398	216	144	360	191	132	323
1978	257	166	423	228	153	381	199	139	338
1979	270	176	446	239	161	400	207	146	353
1980	283	186	469	248	169	417	214	152	366
1985	332	225	557	287	201	488	242	177	419
1990	335	227	562	288	202	490	241	176	417
1995	331	229	560	284	203	487	236	176	412
2000	370	264	634	316	233	549	263	202	465
DOCTOR'S DEGREES									
1970	25.9	4.0	29.9	25.9	4.0	29.9	25.9	4.0	29.9
1971	28.8	4.7	33.5	28.5	4.6	33.1	28.3	4.6	32.9
1972	31.3	5.5	36.8	30.8	5.3	36.1	30.3	5.2	35.5
1973	33.6	6.4	40.0	32.8	6.1	38.9	32.0	5.9	37.9
1974	36.6	7.3	43.9	35.2	6.9	42.1	33.8	6.5	40.3
1975	40.5	8.3	48.8	38.0	7.7	45.7	35.5	7.1	42.6
1976	45.4	9.4	54.8	41.4	8.5	49.9	37.5	7.7	45.2
1977	51.2	10.7	61.9	45.3	9.4	54.7	39.7	8.2	47.9
1978	57.1	12.0	69.1	49.2	10.3	59.5	41.8	8.8	50.6
1979	62.9	13.4	76.3	53.1	11.3	64.4	44.2	9.4	53.6
1980	68.8	14.9	83.7	57.1	12.4	69.5	46.5	10.0	56.5
1985	88.0	20.2	108.2	71.1	16.2	87.3	55.8	12.7	68.5
1990	99.5	23.8	123.3	79.5	18.9	98.4	61.6	14.5	76.1
1995	95.8	23.4	119.2	76.2	18.4	94.6	59.7	14.2	73.9
2000	97.7	24.3	122.0	77.6	19.1	96.7	59.5	14.5	74.0

awarded will increase by about 90% by 1980. Projections B are approximately midway between Projections A and C. Note that all three sets of projections agree quite closely for the next two or three years. The recent job market squeeze in certain fields should not have an appreciable immediate effect upon doctorate production, because the time-lapse between graduate school entrance and the completion of doctoral programs is almost always four years or more and it is unlikely that large numbers of doctoral students in the intermediate or terminal stages of their programs will discontinue them on account of this factor.

The NCES projections of master's and doctor's degrees to 1978-79 in [25] indicate that the number of master's degrees awarded will increase by 95% between 1969 and 1979; the corresponding percentage increases for Projections A, B, and C are 130%, 106%, and 82%. According to their projections, doctorate production will rise by 97% between 1970 and 1979; the corresponding percentage increases for Projections A, B, and C are 155%, 115%, and 79% respectively.

The Mayhew study cited earlier showed that among the institutions responding to his survey the anticipated rate of growth of advanced degree production was such that, if the same rate applied to all institutions offering graduate programs in 1968, there would be 67,500 doctor's degrees and 344,000 master's degrees awarded in 1980-81 [20, p. 1]. Since these figures exclude the new graduate schools to be created between now and 1980, the projection of 67,500 doctor's degrees tends to support Projection B.

THE ECONOMIC RECESSION AND THE LABOR MARKET

Whereas undergraduate enrollment rates are apparently insensitive to the state of the economy, the effect of the present economic recession upon graduate enrollment patterns is not clear. As can be seen from Figures 1 and 2, whereas the 1957-58 recession may have reduced graduate enrollment rates slightly, the 1960-61 recession had no apparent effect. The current recession differs from the earlier ones in that it is accompanied by a much more severe job market squeeze for holders of advanced degrees. The long-term job outlook, especially the demand for teachers, is a potential factor that may have a tremendous impact, not only upon graduate enrollment patterns, but upon all aspects of graduate education as graduate students adjust their programs of study to give themselves greater opportunities for future employment.

Before the current recession, which some economists date from July of 1969, many professional occupations had suffered worker shortages of lengthy duration; this was especially true in the fields of teaching, physics, chemistry, and biomedical and health occupations [6]. Almost within a single year, the job situation in the fields of teaching, physics, and chemistry changed from shortage to surplus. The surplus of elementary and high school teachers was a predictable result of the fact that the number of births in the U. S. leveled off in the late 1950's and has declined every year since 1961. (See [7].) As a result, elementary schools across the nation are now experiencing enrollment decreases, and high school enrollments are peaking out. On the other hand, the number of new college graduates with teaching credentials has been increasing sharply in the last two years as an aftereffect of the postwar baby boom of the late 1940's.

The resulting present surplus of elementary and secondary teachers and the prospects for the future present a dismal outlook for this field, which has been the largest source of professional opportunity for women in the past. This is bound to have an effect upon graduate enrollments, especially in the field of education. In the long run one would expect a reduction of students enrolling for advanced degrees in preparation for teaching below the college level, but the short-term effect is not clear. How can one explain the popularity of the field of education among new graduate school entrants of both sexes in the last two or three years? Perhaps the "new consciousness" of college youth includes an obliviousness to job market considerations.

The demand for college teachers will be considered in detail in a later paper. In brief, the production of potential college teachers, including most Ph.D.'s and Ed.D.'s, is rising much more rapidly than enrollments, and the results are again predictable. The current rate of doctorate production exceeds the past rates by such a wide margin that, even if future doctorate production could be frozen at the 1970 level (about 30,000), the stock of living American Ph.D.'s of age 70 or less would still increase by over 80% between now and 1980. Under Projections A, B, and C, the percentage increases would be about 160%, 145%, and 130% respectively. These conclusions follow from applying recent mortality statistics to the numbers of Ph.D.'s produced in the past and the additional assumption that the age distribution of new Ph.D. recipients in any year is about the same as it was in 1966. (See [21].) From these and other considerations, it is clear that a much higher proportion of the new Ph.D.'s will be employed in fields other than college teaching than has been the case in the past.

The present surplus of engineers, physicists, and chemists apparently results primarily from curtailment of expenditures for research in the

defense and aerospace industries and from "belt-tightening" by other industries on research expenditures in the face of the recession. However, the U. S. Department of Labor [6] reports a favorable long-term outlook in these fields and in the other physical sciences. In this connection it should be recalled that the proportion of graduate students entering these fields has been decreasing precipitously for the last ten years. The reduced federal commitment to support students in these and other technological fields may result in a shortage of highly trained workers in these fields by 1980. The Department of Labor warns of possible surpluses of mathematicians and life scientists if students continue to elect to major in these fields in the same proportions as in the past. The fields of medicine and computer technology continue to have a bright future in employment opportunities. For a comprehensive survey of the market for holders of advanced degrees by field of specialization, the reader is referred to Human Resources in Higher Education by Folger, Bayer, and Astin [12]. This book, which is a staff report of the Commission on Human Resources and Advanced Education, also contains a thorough review of the literature on the flow of students through the graduate school, the current status of women graduate students and faculty members, and other aspects of higher education.

Another viewpoint on the long-term future demand for technicians is that of Zbigniew Brzezinski [4, 5], who forewarns that our industrial society is evolving very rapidly into a "technetronic society," which will be shaped culturally, psychologically, socially, and economically by the impact of technology and electronics, particularly computers and communications. In his view, the transformation will occur with great force within a short period of time and will have a profound effect upon the social structure, the mores, and the values of our society.

In particular, Brzezinski predicts that the university will change from "an aloof ivory-tower, the repository of irrelevant, even if respected, wisdom, and, for only a brief time, the watering fountain for budding members of the established social elite" to "an intensely involved think-tank, the source of much sustained political planning and social innovation." [4, p. 18]. Also, the change may serve as a tremendous impetus to future graduate enrollments (but not necessarily to enrollments for advanced degrees, since degrees may lose some of their earlier relevance). Brzezinski anticipates that the educational process, which will rely much more on electronic audiovisual devices, will become even lengthier than it is at present, and more refresher studies will be essential. He predicts a need "to require everyone at a sufficiently responsible post to take, say, two years of retraining every ten years...Otherwise, it will not be possible either to keep up with, or absorb, the new knowlege." [4, p. 22].

CONCLUSIONS

The primary factor underlying the growth of graduate enrollments in the post-Sputnik era has been the growth in the numbers of college graduates during this period, which in turn is due to the increase in the size of the college age group, greater holding power on the part of the high schools, and increases in the college entrance rates among high school graduates. About two-thirds of the growth in graduate enrollments since 1957 is attributable to the growth in the numbers of college graduates.

The proportion of college graduates going on to graduate school increased sharply between 1957 and 1965, at the same time that federal expenditures on graduate education soared. However, only a small part of the growth in graduate enrollments can be attributed to these expenditures, since relatively few graduate students are supported by federal stipends. The graduate school entrance rates for men dropped in 1966 and 1967 as the number of draft calls during the Vietnam buildup increased. They decreased further in 1968 and 1969 when most deferments for graduate students were eliminated.

With the reduction in draft calls in 1970 and 1971 and the change in Selective Service policy shifting the burden of the draft to the 19-year-old age group, the effects of the draft on graduate enrollments should be less noticeable in the future. Instead, the aftereffect of the draft -- the return of large numbers of veterans to the campuses under the G. I. Bill -- should swell graduate enrollments for the next several years. This should push the graduate entrance rates back toward their 1965 high, but the period of recovery will probably take at least two years and perhaps much longer.

The effect of the current depressed market for highly trained manpower upon the graduate enrollment pattern is as yet unpredictable. Earlier warnings (see [16]) of the anticipated oversupply of college graduates made in 1948 during a period of economic recession had no apparent effect upon undergraduate enrollments and degree production, but the analogy between the two situations is hard to draw.

The graduate enrollment pattern for students after they enter the graduate school has been quite stable since 1957, the only noticeable exception being a very slight increase in the proportion of entering students who complete doctoral programs. This trend may reverse itself in the near future in response to the repeated warnings of the potential oversupply of college teachers.

According to three series of projections given in the paper, graduate enrollments will continue to rise through the 1970's, but at a slower annual rate than was experienced in the 1960's. There will be a leveling off of graduate enrollments about 1985 according to all three sets of projections, with slight declines anticipated in the late 1980's as an aftereffect of the reduced numbers of births in the U. S. beginning in 1961.

Doctorate production will also continue to increase during the 1970's but at a rate somewhat below the average of 12% per year during the 1960's. Since the future demand for college teachers in most fields would be more than satisfied with no further increases in doctorate production above the 1970 level, this raises many questions about the nature of the present extremely costly and time-consuming doctoral programs and the desirability of creating new doctoral programs in emerging institutions when the resources are sorely needed at other levels of education.

Doctoral programs are supposedly designed to train research-oriented university professors, but only a small proportion of the graduates in the 1970's can expect to be employed in such positions since the total enrollments in all institutions of higher education is expected to increase by only 50-60% in the next decade, and the junior colleges are expected to take 40-50% of the increase [15]. Doctoral training is often so highly specialized that the student has a limited potential for employment in other areas. Some have argued that Ph.D. training is not even relevant to college teaching and have recommended against the hiring of large numbers of Ph.D.'s in the junior colleges. Clearly, the graduate students of the 1970's need to adapt their programs of study to improve their chances for future employment, the institutions need to do a little soul-searching about the desirability of modifying their doctoral programs, and efforts at all levels must be made to reassess the purposes of graduate education and the directions in which it is headed today.

APPENDIX

SOURCES FOR THE DATA AND SOME STATISTICAL METHODOLOGY

The estimates of graduate resident enrollment for the years up to 1963 result from breaking down total opening fall degree-credit enrollment by level and sex, as given in [25], using the corresponding proportions of enrollments in this category derived from the biennial "comprehensive enrollment surveys" from 1955 to 1963. (See [39].) The analogous ratios for the even-numbered years are estimated by interpolation. The 1968 estimates of graduate resident enrollment are taken from the residence and migration study of 1968 [26]. The estimates for the years 1964-1967 and 1969 result from applying the yearly growth rates in enrollments for advanced degrees.

The available data on enrollment for advanced degrees can be found in [28] and earlier NCES publications in this series. Intermediate and terminal-year enrollments for 1969 were estimated by subtracting first-year enrollment from total enrollment, and then breaking down the remainder into the two levels according to the 1968 proportions. The reported data for 1966 were adjusted to include estimates of enrollments for nonreporting institutions based upon the 1967 data for those institutions. To account for expansion of the survey between 1963 and 1964, the data for 19[illegible] 1963 were first increased by 2.6%, then deflated to exclude estimates of enrollment in outlying areas. The amount of the increase results from comparing reported enrollment for 1963 with an estimate of what enrollment would have been in 1963 under the same expansion, based upon comparisons of enrollments in

those fields that were unaffected by tne expansion. The resulting estimates of enrollment by level for 1960 were adjusted further from 201700, 106500, 13800 to 205900, 103000, and 13000 for the following reasons: for many fields, 1960 was the first year of the survey for enrollments by level, and in some fields the reported increases within levels between 1960 and 1961 are highly suspect (especially terminal-year enrollments in education and psychology). The figures chosen for intermediate and terminal-year enrollments in 1960 lead to estimates of enrollment increases by level between 1960 and 1961 that are more consistent with the increases reported in those fields which were also surveyed in 1959.

The data on enrollment for advanced degrees for 1959, the first year for which this data was gathered, was not used since it was incomplete and the reported rate of increase between 1959 and 1960 did not agree closely with the rate for graduate resident enrollment. Total enrollment for advanced degrees for the years 1955-1959 was estimated by applying appropriate factors to graduate resident enrollment based upon the ratio of these enrollments in 1960. The resulting total enrollments $g(t)$ were then broken down by level using the formulas:

$$g_1(t) = g_1(1960) - .716[g(1960)-g(t)]$$

$$g_2(t) = .888[g(t)-g_1(t)]$$

$$g_3(t) = .112[g(t)-g_1(t)].$$

The rationale behind these formulas was: (a) 71.6% of the increase in $g(t)$ between 1960 and 1965 was at the first-year level; (b) in 1960, $g_2(t)$ was 88.8% of $g(t)-g_1(t)$, and $g_3(t)$ was 11.2%.

Before 1966 the survey on enrollment for advanced degrees did not gather enrollments separately for men and women. The enrollments for advanced degrees by sex in Table 3 result from first applying the proportions

of women obtained from the graduate resident enrollments and then multiplying the result by .948, which is the ratio of .3048 (proportion of women in the 1966 enrollment for advanced degrees) to .3216 (proportion of women in the 1966 graduate resident enrollment). These total enrollments by sex were then broken down by level using the assumption that the ratios $g_i^m(t)/g^m(t)$ for men were constant multiples of the ratios $g_i(t)/g(t)$ for both sexes combined, where the multiples a_i were determined using the 1966 data. Thus, $g_i^m(t) = a_i g_i(t) g^m(t)/g(t)$ and $g_i^w(t) = g_i(t) - g_i^m(t)$. The reason for doing this is that the ratios $g_i(t)/g(t)$ are weighted averages of the ratios for men and women separately with weights proportional to the enrollments by sex. This puts most weight on the male ratio, implying that the ratios for men should follow more closely the pattern of the ratios for men and women combined. This method of breakdown leaves the ratios for women relatively stable, which is as it should be since the number of bachelor's degrees awarded to women has risen more consistently and the enrollment patterns for women are less affected by wartime factors.

The estimates of the numbers of bachelor's degrees in Table 6 are based upon data in [24] and earlier publications in the same series. For the years up to 1960, the number of bachelor's degrees was not reported separately but was included in the counts of bachelor's and first-professional degrees. Estimates of the numbers of first-professional degrees for the years 1955-1960 were obtained by deflating the 1961 estimate backwards over time, using growth rates in degree production for the combined fields of dentistry, medicine, law and library science.

The projections of bachelor's degrees used in making the projections of graduate enrollments are given in Table 11. The methodology behind these projections is discussed in [15].

Table 11

Projections of Numbers of Bachelor's Degrees Awarded, United States, 1970-2000
(All projections are in thousands)

Year	Men	Women	Year	Men	Women	Year	Men	Women
1970	427	331	1980	622	544	1990	604	549
1971	436	344	1981	632	558	1991	608	554
1972	465	368	1982	650	575	1992	612	559
1973	494	394	1983	666	590	1993	624	571
1974	514	423	1984	671	595	1994	642	588
1975	544	450	1985	670	596	1995	662	608
1976	572	475	1986	662	592	1996	682	628
1977	581	487	1987	644	578	1997	702	648
1978	597	508	1988	624	562	1998	722	668
1979	612	528	1989	608	550	1999	743	688
						2000	764	709

We now turn to the methodology for estimating the parameters in equations (8) - (10), beginning with the parameter γ_1 in (8). First, $n(t)$ was replaced by $f(t)\,x(t)$ in (8); then since the first-time enrollment rate $f(t)$ was seen to be approximately linear in t during the period 1960-1965 for both men and women, as indicated by the ratios $g_1(t)/x(t)$ in Table 5, (8) was replaced by the following approximate relationships for men and women for the years 1960-1965:

$$g_1^m(t) = [\alpha_1^m + \beta_1^m(t-1961)]\,x(t) + \gamma_1^m\,g_1(t-1) + e_1^m(t)$$

$$g_1^w(t) = [\alpha_1^w + \beta_1^w(t-1961)]\,x(t) + \gamma_1^w\,g\,(t-1) + e_1^w(t).$$

Expansion of the right-hand sides of these equations leads to a linear model in the parameters, and standard least-squares regression techniques can be applied to estimate the parameters. However, there is a particularly acute "multicollinearity" problem here with only six data points, so that two other factors were incorporated into the estimation process. As can be seen from the equations above, the parameters α_1^m and α_1^w have the interpretation as first-time graduate enrollment rates for 1961. Since the ratio of these enrollment rates is "known" from the NORC survey of the class of 1961, the side condition $\alpha_1^w = .78\,\alpha_2^m$ was imposed. The .78 figure results from taking the three-year averages of the enrollment rates in [37] after those rates had been deflated by 20.5% for men and 1.6% for women to eliminate the proportions of professional enrollments [38, p. 38]. The other factor considered was that the 1960-1965 data on enrollments for advanced degrees by sex had to be estimated since the data was not gathered separately for men and women before 1966. To tie the estimation process more closely to more reliable data, namely the data on total

enrollment for advanced degrees, the following equations for total enrollment were incorporated into the model:

$$g^m(t) = [\alpha_1^m + \beta_1^m(t-1961)]\, x(t) + \delta^m\, g(t-1) + e^m(t)$$

$$g^w(t) = [\alpha_1^w + \beta_1^w(t-1961)]\, x(t) + \delta^w\, g(t-1) + e^w(t).$$

Here, δ^m and δ^w represent overall (adjusted) retention rates analogous to the adjusted repeat rates γ_1^m and γ_1^w in the preceding equations. Thus, the parameters in these equations were estimated by least-squares using the 1960-1965 data in the four equations above with the specified side condition.

The parameters in equations (9) - (10) were estimated by least-squares from the data for the years 1960-1969. Earlier computer runs had indicated little change in these estimates when only the data for the years 1960-1965 (or for the years 1960-1967) were used.

The sources of data on numbers of master's and doctor's degrees for the years up to 1969 come from the NCES publication [24] and earlier reports in the same series. The 1970 estimates of doctorate production are based upon data in [29] and [30] which show that between 1969 and 1970 the number of doctorates awarded increased by 14% for men and 17% for women.

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